

SANDIA NATIONAL LABORATORIES
Albuquerque, New Mexico 87185

WIPP Procedure No. 001
Revision No. 13
Effective Date 5-8-91
Page 1 of 14

TITLE: CALIBRATION OF HP-3456A AND EDC-501J INSTRUMENTS

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PURPOSE: The purpose of this document is to provide information about and a method to perform calibration of DAS instruments.

RESPONSIBILITY: It is the responsibility of the person(s) performing this procedure to be familiar with this procedure and references. They are also responsible for assuring that the Datron Autocal Standards Multimeter and the Guildline Standard Resistors being used are in current certification. **USE OF CALCULATOR REQUIRED** for performance test records calculations. After the calibration is completed the Performance Test Record will be submitted to the Calibration Project Leader or alternate for review.

SAFETY: There are no safety concerns other than as noted in this procedure.

FORMS:

- I. Form 159 - DC Voltage Standard Model 501J DC Volt Test
- II. Form 160 - HP3456A Digital Voltmeter DC Volt Test
- III. Form 161 - HP3456A Digital Voltmeter Ohms Test
- IV. Form 162 - HP3456A Digital Voltmeter AC Volts Test
- V. Form 163 - Data Acquisition System Operational Test
- VI. SA-75-71-1 - Standards Laboratory Instrument Record

REFERENCES:

- I. DIGITAL VOLTMETER: HP-3456A OPERATING AND SERVICE MANUAL
- II. PROGRAMMABLE DC VOLTAGE STANDARD: EDC-501J OPERATORS' MANUAL
- III. PRECISION MULTIMETER: DATRON 1081 REFERENCE MANUAL
- IV. PRECISION MULTIMETER: DATRON 1281 REFERENCE MANUAL

NOTE: The 1081 specifications and operating instructions apply identically to the 1082. All references to "1081" should be read as "1081 and 1082".
The Datron 1281 meter may be used in place of the Datron 1081.

PROCEDURE:

I. INFORMATION

A. Introduction

These calibration tests for the HP-3456A Digital Multimeter and an EDC-501J Precision Voltage Source are performed on station using transfer standards that are traceable to Sandia National Laboratory's Secondary Standards Lab. This procedure is written to maintain the Carlsbad WIPP Site as a CALIBRATION STATION and as such the station is subject to periodic audits by Sandia Secondary Standards Lab. The audit will consist of a review of equipment and techniques used by personnel to establish and maintain a high degree of accuracy as intended by this document. The calibration is performed on station using a precision Multimeter, a precision ac voltage source, 4 precision resistors, and interconnecting wiring as required. The purpose of calibration is to take into account any long term drifts in the components of the instruments and restore measurement accuracy. After all instruments have been certified, the transfer standards are returned to SNLA to close the loop. If the transfer units are out of calibration or found to be defective on their return to SNLA, the entire procedure must be repeated. This method should eliminate the damage caused in shipping and handling as well as the corrosion that occurs when the instruments are removed from the dry salt environment into a humid atmosphere. If careful attention is given to all aspects of this procedure, accurate measurements can be made for all data taken on behalf of the WIPP project.

B. General

The primary reference for this transfer station is the DATRON Precision Multimeter. Normally, in order to establish a confidence in the ability for one system to calibrate another, the transfer standard should have an accuracy of 4 times that of the meter being calibrated. In this case the accuracy is stated to be something over twice that of the HP-3456A. Even so, the DATRON gives the Secondary Laboratories difficulty to provide standards that can improve on its performance. In the test procedures given, the DATRON is used in parallel with the other meter when checking DCV and ACV. The OHMS calibration must be made separate using 4 resistor standards since the current generated by the meters interfere with each other.

C. Test considerations

1. Calibration Interval: Initially the test interval will be established as 6 months.
2. Temperature: The temperature of the environment will be the temperature of the shed (60 to 78 deg. F). The meters to be calibrated should be left in the equipment rack as this environment establishes their operating temperature. The DATRON 1081 and other standards should be operated in their normal operating position. Avoid direct drafts from air conditioners and allow plenty of room for ventilation.
3. Warm up: It is essential that the instruments have been fully stabilized if the best results from calibration are to be achieved. At least 2 hours warm up time should be allowed before making comparisons. If ac power is lost for any reason, the warm up should be repeated.
4. Settling Time: Allow 10 seconds settling time after input values have been changed before taking readings.
5. Data Scans: Calibration of the meters must be coordinated with the data scan interval to eliminate interference with normal measurements. Request B-49 operator to deactivate the appropriate scan type prior to changing the DAS configuration.
6. Guarding: The local guard condition on the DATRON must be selected.
7. Wiring: Use solid, coated copper wires as stranded wires create thermal EMF's at the terminals .

8. Handling: The transfer standards must be treated with care. Carrying cases will be provided to hand carry units between Albuquerque and the mine.
9. Connections: Test signals are better applied to the front connectors for the HP-3456A. Take care to return the option to the rear connections before the next data scan. The EDC-501J output jacks have been hard wired to the front mounting panel of the bus extender for easy access and shorter wire lengths.

D. Ambiguous tolerance region

In the event that a calibration reading falls at or near the outer limits of acceptability, a region of uncertainty exists due to possible errors in transfer standard. For example the 1.0 volt limit for an HP-3456A is 28ppm. If this limit is added to the 13ppm of the DATRON 1081 then the total could be 41ppm and still be within the accuracy expected of the meter. This problem emphasizes the need for extreme care in making all measurements.

E. Definitions

Following are the definitions which describe the actions to be taken during abnormal conditions.

1. Outside Acceptance Tolerance

When a reading is taken which exceeds the limit given on the Performance Test Record, this represents "Outside Acceptance Tolerance" and requires the following actions:

- a. Perform the meter adjustments.
- b. The Calibration Project Leader or alternate will perform calculations which establish the percent of error introduced.
 - 1) If the data are acceptable the Calibration Project Leader or alternate will sign or initial the Performance Test Record indicating this condition.
 - 2) If the data are questionable or unacceptable, a non-conformance report will be completed. The Performance Test Records and the error calculations will be attached and distributed to the appropriate Principal Investigator.

2. Outside of Adjustment

When a reading is taken which exceeds 50% of the limit given on the Performance Test Record, this represents an "Adjustment Tolerance Trigger" and not an "Outside Acceptance Tolerance" and recommends the following action:

- a. Perform the meter adjustments. If it is not possible to bring the readings within the 50% limit but they are still within stated limits then notify the Sandia Calibration Project Leader or alternate.

F. Meter Adjustments

Over a period of long term use, the meters will gradually drift out of calibration as components age and the possibility of carbon silt being deposited on component boards. When the instrument under test has drifted more than the defined tolerances then it must be readjusted to its defined limits. The procedure is given in section four and five of the manual for the HP3456A and section five of the manual for the 501J.

G. Equipment Requirements

1. DCV Test

DATRON Autocal Standard Multimeter Model 1081, 1082, or 1281
EDC Voltage Standard Model 501J

2. OHMS Test

Guildline Resistance Standard Model No. 9330-100
Guildline Resistance Standard Model No. 9330-1K
Guildline Resistance Standard Model No. 9330-10K
Guildline Resistance Standard Model No. 9330-100K

3. ACV Test

DATRON Autocal Standard Multimeter Model 1081, 1082, or 1281
John Fluke AC Voltage reference Model No. 510A, 60 Hz.
John Fluke AC Voltage reference Model No. 510A, 400 Hz.
EDC AC Voltage reference Model 4032

NOTE: The 4032 may be used in place of the two Fluke AC references.

Gertsch Ratio Standard Model 1011 or Eaton Model 1011A

H. Performance test Records

Calibration data forms (form 159 - 162) are provided giving the step by step procedure to be used. On the forms is a column giving the limits to which the meters are to be accepted or rejected. The limits given represent the RMS (Root Mean Square) value of the combined extremes for the meter being tested and The DATRON transfer standard. In short, the limit listed is the square root of the sum of the squares for both extremes. It is based on the probability of the two meters being at their extreme limits at the same time. In some cases, the accuracy of the DATRON does not change the limit given for the meter. The difference between the Datron and instrument being calibrated is used to determine out of tolerance conditions.

All calibrations are performed in three steps.

NOTE: All initial data must be taken for each function to be calibrated before any adjustments are made unless it can be verified that the instrument under test has been out of service (not used to take data) since its last calibration

- I. Step 1: Record all data without making any adjustments. Check Initial on Performance Test Record.
- J. Step 2: If required, make adjustments as shown in figures 2 or 3.
- K. Read and record all data. Check After Adjustment on Performance Test Record.

All performance test records (forms 159 - 163) shall be given to the Calibration Project Leader to be evaluated for possible effects on past data measurements. Two copies will be made by the Calibration Project Leader. The original and one copy will be forwarded to the SNL QA representative and the last copy will be filed by the Calibration Project Leader.

II. Performance Tests

Before any tests are made with the DATRON, "zero" the meter as follows: Connect a good copper short between the input terminals. Set the meter switches for "DC", "AUTO", "FILTER", and push "ZERO". Wait for the meter to zero itself thru all DC ranges.

A. DCV Test: Output voltage EDC-501J

1. Connect the front panel output terminals for the EDC

Voltage Standard to the DATRON.

2. Conduct the test in accordance with the steps given in form 159. Record Initial data and Rack temperature.
3. Adjust the potentiometers as given with each step if the instrument exceeds any limit or if the instrument exceeds 50% of limits given for measurements which have an impact on data being taken. Adjustment locations are shown in Figure 1.
4. Conduct the test in accordance with the steps given in form 159 and record After Adjustment data.

B. Preliminary Short Test for the HP3456A

In order to check that the "front", "rear" terminal switch on the HP-meter is working properly, put a four terminal short on the terminals and measure the resistance. If a resistance value is measured and/or the display is erratic, operate the switch a few times and see if it will clear. If not, turn the meter off, remove from the rack and clean the switch with contact cleaner. Move the switch back and forth as it is being sprayed. Repeat the resistance test with the meter on the bench.

Note: Do not remove or install the top cover with power on.

C. DCV Test: Test Procedure HP-3456A (form 160)

1. Switch the meter to front terminal mode. Note paragraph "B" above. Remove any short and press the TEST button.
2. Press the RESET button

NOTE: Pressing the reset button automatically sets the 3456A to DCV, Autorange, Internal Trigger, and 5 Digit Display.

3. Set the unit to 6 digit display by pressing the following: 6-STORE-N DIG DISP.
4. Short the VOLTS input terminals with solid copper wire. Set the volt range as shown in steps 4 thru 7 (form 160) and record the Initial meter readings.
5. Connect the HP-3456A and the DATRON in parallel with the EDC-501J Voltage Standard.

6. Initial Control Set Up
DATRON

HP-3456A

| | | |
|---------------|-------|------|
| Trigger | | Int |
| Range | Auto | Auto |
| Function | DCV | DCV |
| Guard | Local | Off |
| Auto | | On |
| Math Function | | Off |

7. Perform the tests given in steps 8 thru 20 (form 160) and record the Initial meter readings.

8. Perform the previous steps and adjust the meter as shown in figure 2 for this function if the instrument exceeds any limit or if the instrument exceeds 50% of limits given for measurements which have an impact on data being taken. Adjustments for other functions are not required because of this out of limits condition.

a. Perform the previous steps and record the After Adjustment meter readings.

NOTE: If the data are still outside of the acceptance tolerance, contact the Calibration Project Leader. (ALL tests)

D. OHMS Test HP-3456A (form 161)

1. Press the RESET button

2. Set the meter for 6 digit resolution

3. Short all four terminals with copper wire and record the Initial readings as given in steps 3 and 4.

4. Connect the Resistor Standards in the desired order given in steps 5 thru 12 (form 161). In steps 11 and 12 the meter is set to the 100k Ohm range. The O.C refers to "Offset Compensation". All readings are 4 wire unless otherwise stated.

a. Connect the RATIO REF. to C terminals.

b. Connect the VOLTS terminals to the P terminals.

5. Record the value given for the Resistor Standard and the Initial meter reading.

6. If any limits are exceeded then perform the previous steps, in the specified order, and adjust the meter as shown in Figure 2 for the OHMS function. Adjustments for other functions are not required because of this out of limits condition.

- a. Perform the previous steps and record the After Adjustment meter readings.

E. ACV Test HP-3456A (form 162)

1. Perform steps 1 and 2 of form 162
2. Connect the 400 HZ Fluke 510 AC Standard to the input of the Gertsch Ratio Standard. (If using the EDC model 4032, select 400 HZ at 10 volts and connect it to the Gertsch input.)
3. Connect the output of the Gertsch to the DATRON Multimeter and the Meter under test.
4. Conduct the test as given in steps 3 thru 9 (form 162) and record the Initial meter readings.

NOTE: Replace 400 HZ Fluke AC reference standard with 60 HZ model for steps 8 and 9. (If using the EDC Model 4032, change the frequency to 60 HZ.)

5. Perform the previous steps and adjust the meter as shown in figure 2 for this function if the instrument exceeds any limit or if the instrument exceeds 50% of limits given for measurements which have an impact on data being taken. Adjustments for other functions are not required because of this out of limits condition.

- a. Perform the previous steps and record the After Adjustment meter readings.

III. Post Calibration Procedures

- A. Request B-49 operator to reactivate appropriate scan type.
- B. Sandia form STANDARDS LABORATORY INSTRUMENT RECORD (SA-7571-1) shall be filled out for each meter calibrated and supplied as part of the records of certification.

- C. Affix a label to the face of each meter calibrated. The label shall include:
 Serial Number
 Property Number
 Cal Expiration Date
 Calibrators Initials
- D. Switch the HP-3456A to the "rear" terminals. Check the transfer by connecting a short to the terminals (or distribution box in rack). The result should be as described in section II paragraph B.
- E. OPERATIONAL CHECK
1. Complete appropriate step of form 163 to verify the system is operating correctly. Forward form 163 to the SNL APL or the Calibration Project Leader.
 2. If approximate reading is not attained, recheck system to verify and correct cause of erroneous reading.
NOTE: This check is necessary only when active DAS equipment was involved in the calibration procedure.

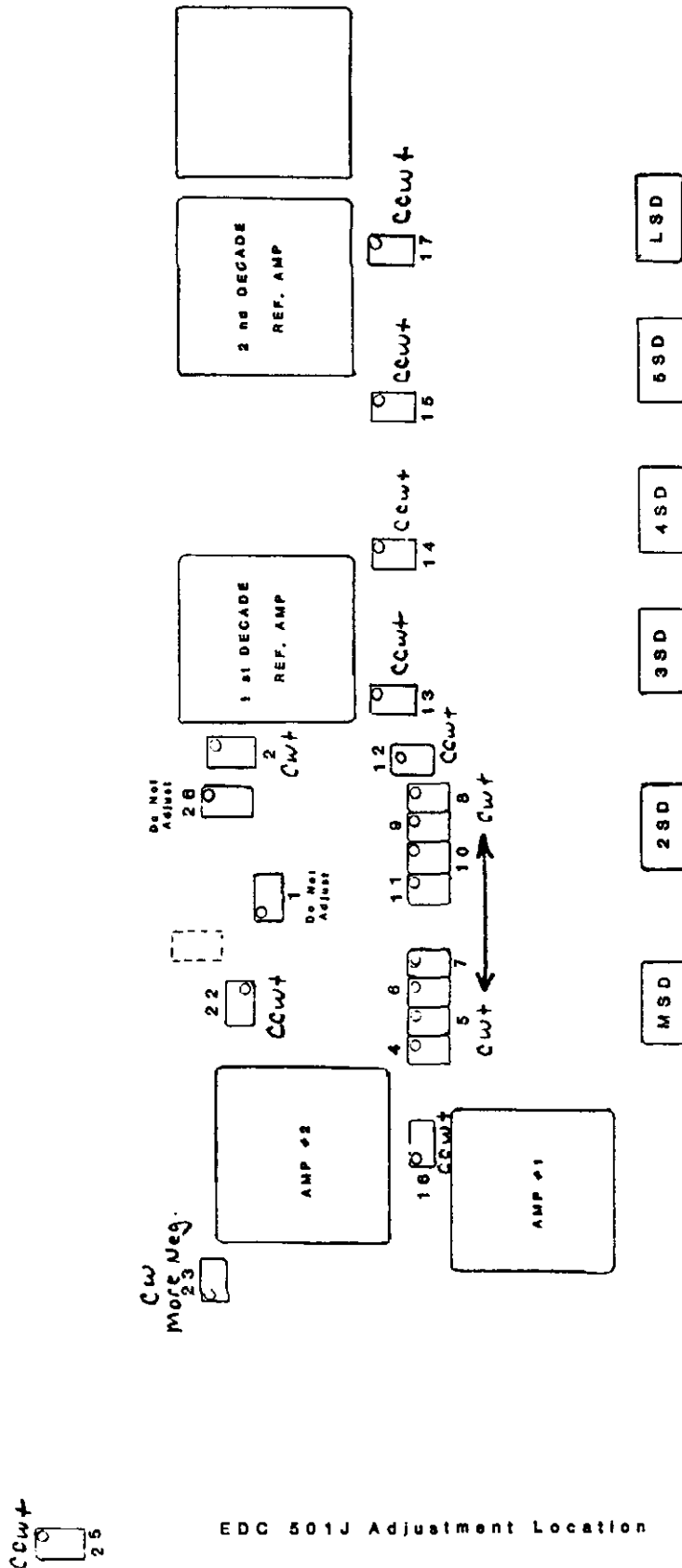


Figure 1

Table 5-1. 3456A Adjustments.

| Step # | Adjustment Pot | 3456A Function | 3456A Range | Input to the 3456A | Displayed Reading | Tolerance in Counts | General and Set-Up Information |
|--------|----------------|----------------|-------------|--------------------|-------------------|---------------------|---|
| 1 | | | | | | | Reset the 3456A. Set to 6 digit. Connect GUARD to LOW. |
| 2 | A & B | DCV | 10 V | + 10 V DC | + 10.00000 | ± 1 | Adjustment "A" is coarse; "B" is fine. |
| 3 | C | DCV | 1 V | + 1 V DC | + 1.000000 | ± 1 | |
| 4 | D | DCV | 100 mV | + .1 V DC | + 100.0000 -3 | ± 5 | Enable the 3456A's Null Math feature to correct the 100 mV offset. |
| 5 | E | DCV | 100 V | + 100 V DC | + 100.0000 | ± 1 | |
| 6 | | | | | | | Set the 3456A to the 4-Wire Ohms function. |
| 7 | F | 4-W Ohms | 10 kΩ | 10 K ohm | 10.00000 + 3 | ± 1 | |
| 8 | G | 4-W Ohms | 1 kΩ | 1 K ohm | 1000.000 | ± 1 | |
| 9 | H | 4-W Ohms | 100 kΩ | 100 K ohm | 100.0000 + 3 | ± 1 | |
| 10 | I | 4-W Ohms | 1000 kΩ | 1 M ohm | 1000.000 + 3 | ± 2 | |
| 11 | J | 4-W Ohms | 10 MΩ | 10 M ohm | 10.00000 + 6 | ± 10 | |
| 12 | | | | | | | Set the 3456A to the 5 Digit mode. Repeat Steps 13, 14, and 15 until readings converge. |
| 13 | K | ACV | 100 V | 1 V, 1 kHz | 01.000 | ± 1 | |
| 14 | L | ACV | 1 V | 1 V, 1 kHz | 1.00000 | ± 3 | |
| 15 | M or N | ACV | 1000 V | 1 V, 1 kHz | 001.00 | ± 6 | |
| 16 | N | ACV+DCV | 1 V | Short | Minimum | ± 2 | |
| 17 | M | ACV | 1 V | Short | See Note | ± 2 | Repeat Steps 16 and 17 until readings converge. |

Note: For steps 16 and 17, do the following:

1. Note the 3456A's reading after adjusting pot "N".
2. Adjust pot "M" for a minimum reading and then continue adjusting the pot until the noted reading in Step 16 is reached.

| COMMENTS | RESOLUTION |
|--|--|
| Name TW Spaulding Date 4-10-91 In section I - K. making two copies and sending them to QA is not a step normally performed by Calibration Tech. TWS | comment accepted and incorporated 4/11/91 <i>Jan</i> |
| Name Date | |
| Name Date | |
| Name Date | |
| Name Date | |
| Name Date | |
| Name Date | |

REVISION SUMMARY

To be completed by procedures author before final revision is circulated for signatures.

I. Revisions made: ① deleted performance test records ② changed associated references to reflect form numbers ③ interchanged sec. II para. A with sec II para. B. ④ deleted check list. ⑤ changed terminal reference in II. D. 4. a & b (pg. 8) from "4W4" to "RATIO REF" and "Input" to "Volts" ⑥ added qualification to not take initial data readings. (I. H. on pg. 6)

II. Personnel effected:
(Check appropriate ones)

| Craftsman | Sr Specialist | Specialist | Sr Tech | Tech | Tech Asst | Temp |
|-------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------|
| Drilling | _____ | _____ | _____ | _____ | _____ | _____ |
| Shop | _____ | _____ | _____ | _____ | _____ | _____ |
| Mechanical | _____ | _____ | _____ | _____ | _____ | _____ |
| Electrical | _____ | _____ | _____ | _____ | _____ | _____ |
| Gage | _____ | _____ | _____ | _____ | _____ | _____ |
| Cable/TC | _____ | _____ | _____ | _____ | _____ | _____ |
| U/G DAS | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | _____ |
| DAS Trailer | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | _____ | _____ |
| Geotech | _____ | _____ | _____ | _____ | _____ | _____ |

III. Retraining required:
(Circle one)

Re-read procedure

Practical demonstration

Other (explain)

Signature of
Procedure's Author

J. W. McKeever Date 3/11/91